Government of **Western Australia**
School Curriculum and Standards Authority

BIOLOGY

ATAR course examination 2019

Marking key

Marking keys are an explicit statement about what the examining panel expect of candidates when they respond to particular examination items. They help ensure a consistent interpretation of the criteria that guide the awarding of marks.

2019/62480

Section One: Multiple–choice **30% (30 Marks)**

Question	Answer
1	b
2	d
3	a
4	d
5	a
6	c
7	d
8	c
9	b
10	d
11	c
12	a
13	c
14	b
15	a
16	c
17	a
18	b
19	d
20	c
21	d
22	a
23	d
24	c
25	b
26	a
27	d
28	b
29	c
30	b

Section Two: Short answer **50% (100 Marks)**

Question 31 **(19 marks)**

(a) Define a species. (2 marks)

Description	Marks
Any **two** of:	
Mark one species definition only **Either** Defines the biological species concept • a group of organisms that interbreed • to produce fertile offspring • cannot breed with the individuals of another species **or** Defines the phenetic species concept • a group of organisms that are similar to each other • and are distinct from those in other sets • based on overall similarity (genetic morphological, ecological) **or** Defines the evolutionary species concept • a lineage of organisms that maintains its identity from other lineages • and has its own evolutionary tendencies and fate **or** Provides a taxonomic definition • taxonomic unit/category • that is below genus **or** that comprises populations • main taxonomic/working unit (in biology)	1–2
Total	**2**
Accept other valid species definition	

(b) Explain how new species of dung beetle could evolve by allopatric speciation. (5 marks)

Description	Marks
Explains the process of allopatric speciation (any **five** of):	
• a physical barrier divides population/geographical isolation • prevents gene flow (between the different populations) **or** individuals (from the different populations) from interbreeding • environment/conditions/selection pressures on either side of barrier are different • population on either side of barrier become different due to natural selection • may also become different due to mutation **or** genetic drift • differences will increase/accumulate over time • if individuals are no longer able to interbreed, new species **or** speciation	1–5
Total	**5**

Question 31 (continued)

(c) Describe how genetic drift affects the genetic composition of populations. (3 marks)

Description	Marks
Describes the process of genetic drift (any **three** of):	
• changes allele frequencies • changes are random or occur by chance • (causes) loss of diversity/alleles from a population • (causes) differences between populations	1–3
Total	**3**

(d) Explain how the larger horns in the males of this species could have evolved. (5 marks)

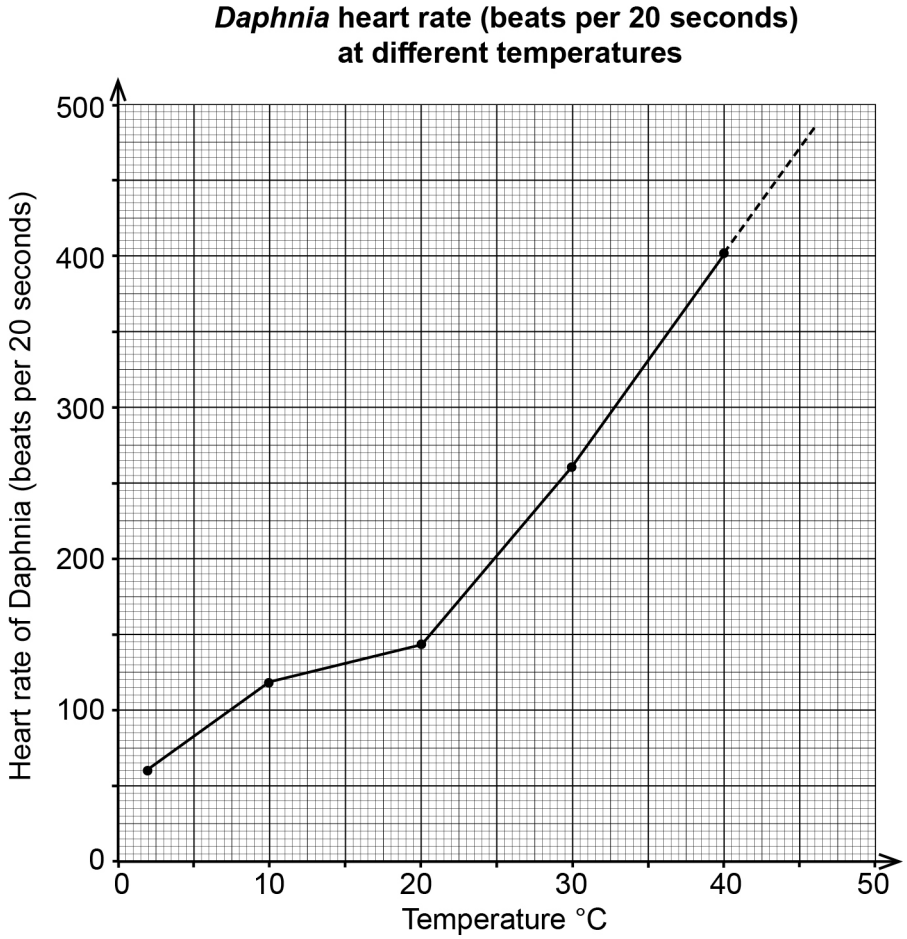
Description	Marks
states that larger horns have evolved by sexual selection **or** due to their disadvantageous effects	1
Subtotal	**1**
Explains how larger horns evolved by sexual selection:	
• larger horns are not favoured by natural selection • females preferred the males with larger horns/males out-compete other males to mate with females • males with larger horns were more likely to mate **or** breed • therefore males with larger horns left more offspring than males with smaller horns **or** passed on allele/s for larger horns to offspring • therefore the frequency of allele/s for large horns increased over time	1–4
Total	**5**

(e) Explain how a phylogenetic tree can represent the evolutionary relationships among different species. (4 marks)

Description	Marks
Explains how a phylogenetic tree can represent the evolutionary relationships (any **four** of):	
• branching of the tree represents the relationships • recent/descendent species are at the tips of branches • shared/common ancestors are at base/trunk of the tree • nodes/branching point represent a common ancestor • branch length represents divergence time/similarities/differences • closely related species will be grouped in same part of tree **or** unrelated species will be grouped in different parts of tree • tree constructed from DNA/morphological/biochemical data (which reflect relationships)	1–4
Total	**4**

Question 32 **(21 marks)**

(a) Graph the mean heart rate of the *Daphnia* against temperature. (6 marks)



Description	Marks
accurate title that includes both variables	1
choose appropriate graph/line graph	1
correctly allocates independent/dependent variables to X and Y axes respectively	1
scale uses correct intervals and graph size is appropriate for grid size	1
correct labelling of both axes including units	1
data points are accurate and accurately joined	1
Total	**6**

Question 32 (continued)

(b) (i) Estimate the heart rate for *Daphnia* at 15 °C. (1 mark)

Description	Marks
135 beats/20 seconds (accept 130–140, must have units)	1
Total	**1**

(ii) Estimate the heart rate for *Daphnia* at 45 °C. (1 mark)

Description	Marks
470 beats/20 seconds (accept 460–480, must have units)	1
Total	**1**

(iii) In which estimate do you have the greater confidence? Give a reason for your answer. (2 marks)

Description	Marks
heart rate at 15 °C or first estimate or (i)	1
this is an interpolation/within the range of the data **or** heart rate at 45 °C is an extrapolation/outside of range of data	1
Total	**2**

(c) (i) What is the independent variable in this study? Give a reason for your answer. (2 marks)

Description	Marks
temperature	1
it is the variable that the investigator controls/changes	1
Total	**2**

(ii) State **one** way of improving the reliability of the study. (1 mark)

Description	Marks
increase the sample size **or** use more *Daphnia* **or** repeating experiment	1
Total	**1**
Note to markers: Must have only one statement to improve reliability.	

(iii) Propose an hypothesis for the study. (1 mark)

Description	Marks
heart rate in *Daphnia* is affected by temperature **or** heart rate in *Daphnia* is not affected by temperature **or** *Daphnia* heart rate increases with increasing temperature **or** increasing water temperature increases heart rate in *Daphnia*	1
Total	**1**

(d) Explain why the biologist waited for 15 minutes before measuring the heart rate of the *Daphnia* at the assigned temperature. (3 marks)

Description	Marks
heart rate depends on temperature	1
(when first added to assigned temperature) heart rate will reflect previous temperature **or** heart rate needs time to adjust to assigned temperature	1
improve accuracy/validity of experiment **or** (not doing so) would lead to inaccurate/invalid results	1
Total	**3**

(e) One of the *Daphnia* had a heart rate of 208 beats per 20 seconds. A biologist concluded that this *Daphnia* must have been assigned to a temperature of 30 °C. Evaluate this conclusion. (4 marks)

Description	Marks
Evaluates the conclusion:	
conclusion is wrong **or** partly wrong **or** only partly right	1
• there is a range of hearts beats for each temperature that is broad **or** overlap those of other temperatures • 208 beats/20 seconds is also within the range of heart rate for 20 °C and 40 °C (can also mention 30 °C) • any accurate quote of data that includes range in heart rate for a particular temperature	1–3
Total	**4**

Question 33 **(20 marks)**

(a) (i) Outline the role of the effector in homeostasis. (2 marks)

Description	Marks
effector receives signals from the processor/coordinating centre/modulator	1
brings about change (needed to maintain homeostasis)	1
Total	**2**

(ii) Outline the role of the receptor in homeostasis. (2 marks)

Description	Marks
receptor detects stimulus	1
sends signal to the processor/coordinating centre/modulator	1
Total	**2**

(iii) State the defining feature of a negative feedback loop. (1 mark)

Description	Marks
response/feedback reduces stimulus	1
Total	**1**

(b) A marine fish regulates its water and salt balance. Is this an example of homeostasis? Give reasons for your answer. (3 marks)

Description	Marks
Example of homeostasis	
yes (must be a clear yes)	1
Subtotal	**1**
Reasons why this is an example of homeostasis:	
• homeostasis is maintenance of a relatively constant internal environment • (marine) fish maintains (relatively) constant salt-water balance despite external environment **or** (marine) fish maintain internal salt concentration at a lower concentration than seawater **or** (marine) fish is osmoregulating to maintain internal salt-water balance	1–2
Subtotal	**2**
Total	**3**

(c) List four features visible in the diagram above that would assist the plant in conserving water. (4 marks)

Description	Marks
Lists any **four** of the following features:	
• stomata on lower surface • stomata in pits or sunken stomata • hairs/trichomes • cuticle (on upper surface) • multicellular/thick epidermis • guard cells	1–4
Total	**4**

(d) The root systems of xerophytes often include spreading roots just beneath the soil surface. Outline **two** advantages of these surface roots for xerophytes. (4 marks)

Description	Marks
Any **two** of the following advantages**:**	
Advantage 1 (large surface area of roots) • (roots) cover a large surface area • increases chances of finding water **or** provide anchorage Advantage 2 (roots close to surface) • can access surface water **or** small amounts of water on the surface • can absorb water before it evaporates **or** can quickly absorb water Advantage 3 (large volume of roots) • large volume (of roots) • more room to store water	1–4
Total	**4**

(e) Some xerophytes produce heat shock proteins in response to heat stress. These proteins prevent the denaturation of other proteins. Explain how this could assist the survival of the xerophyte. (4 marks)

Description	Marks
Explains how heat shock proteins assist survival:	
• proteins/enzymes are essential for organism/cell function • proteins are essential for organism/cell structure • heat can denature proteins • heat shock proteins prevent death **or** heat shock proteins ensure normal function	1–4
Total	**4**

Question 34 **(20 marks)**

(a) (i) Name a disease that is caused by a protist and can be spread by water. (1 mark)

Description	Marks
Phytophthora/jarrah dieback **or** another example	1
Total	**1**

(ii) Name a disease that is caused by a fungus and can be spread by water. (1 mark)

Description	Marks
Chytridiomycosis/amphibian chytrid disease **or** another example	1
Total	**1**

(iii) Name a human viral disease that is transmitted by an insect. (1 mark)

Description	Marks
Ross River fever **or** another example	1
Total	**1**

(iv) Name a human disease that is caused by a protist. (1 mark)

Description	Marks
Malaria **or** another example	1
Total	**1**

(b) Is crown gall an infectious disease? Give reasons for your answer. (3 marks)

Description	Marks
yes (must be a clear yes)	1
caused by a pathogen/bacterium	1
transmitted from one plant/host to another	1
Total	**3**

(c) Describe the method used by *Agrobacterium* to invade the plant host. (4 marks)

Description	Marks
Describes the method that *Agrobacterium* uses to invade plant host (any **four** of):	
• uses flagella to swim to plant • attracted by sugars/chemicals released by wound • (usually) invades through wounds/damaged tissue • bacteria attaches to (plant) cell • transfers (some) DNA/plasmid into plant cell • DNA (permanently) integrates into plant genome	1–4
Total	**4**

(d) Describe the impact that *Agrobacterium* has on the plant host. (5 marks)

Description	Marks
Describes the impact that *Agrobacterium* has on the plant host (any **five** of):	
• causes galls/growths/tumours • (usually) on roots **or** at ground level **or** on roots and stems • (galls/growths/tumours) can prevent the uptake/movement of water **or** nutrients • slows plant growth **or** plants become stunted/unproductive/unhealthy **or** plants can die • *Agrobacterium*/bacteria genes are expressed (in the plant) • (results in) production of some chemicals/hormones (cause the galls/growths/tumours) • also changes expression of (some) plant genes	1–5
Total	**5**

(e) Outline the role that *Agrobacterium* plays in the production of transgenic plants and explain why it is well-suited to this role. (4 marks)

Description	Marks
States that *Agrobacterium* is used as a vector or to transfer foreign genes/target DNA into the plants	1
Subtotal	**1**
Outlines why *Agrobacterium* is well suited to role (any **three** of):	
• because it naturally/normally transfers DNA/genes to plants (during disease production) • and because it can infect a broad range of host plants • this natural ability can be exploited **or** bacteria requires little modification to perform this role • plasmid/DNA contains sequence for integration into plant genome • can be used to clone target DNA	1–3
Total	**4**

Question 35 **(20 marks)**

(a) (i) State **two** similarities between binary fission and mitosis. (2 marks)

Description	Marks
States any **two** of the following similarities:	
• types of cell division • produce genetically identical cells **or** types of asexual reproduction • produce two (daughter) cells	1–2
Total	**2**

(ii) State **two** differences between binary fission and mitosis. (2 marks)

Description	Marks
States any **two** of the following differences:	
• binary fission (mainly) occurs in bacteria/prokaryotes, mitosis occurs in (most) eukaryotes **or** binary fission divides cells without a nucleus, mitosis divides cells with a nucleus • mitosis has a spindle, binary fission does not **or** binary fission divides only a single chromosome type, mitosis divides multiple chromosome types • binary fission is faster **or** mitosis is slower	1–2
Total	**2**

(b) Explain the role of fertilisation in sexual reproduction. (4 marks)

Description	Marks
Explains the role of fertilisation in sexual reproduction (any **four** of):	
• fusion of gametes • combines genetic material from two different parents/male and female parents/egg and sperm • meiosis produces haploid gametes or gametes with only one copy of each chromosome type • restores diploid number of chromosomes **or** ensures individuals have two copies of each chromosome type • create genetic variation/differences	1–4
Total	**4**

(c) (i) Outline how crossing over creates genotypic variation. (2 marks)

Description	Marks
Outlines how crossing over creates genotypic variation (any **two** of):	
• (crossing over) exchanges alleles between homologous chromosomes/pairs of chromosomes • chromosomes therefore have a different/new/unique combination of alleles (compared to those in the parent they were inherited from) • the different/new/unique combination of alleles creates different/new/novel genotypes	1–2
Total	**2**

(ii) Outline how independent assortment creates genotypic variation. (2 marks)

Description	Marks
Outlines how independent assortment creates genotypic variation (any **two** of):	
• homologous chromosomes/chromosome pair separate independently of each (during meiosis I) • form random combinations of chromosomes **or** a (unique) mix of maternal and paternal chromosomes in a gamete • novel combinations of chromosomes creates different/new/novel genotypes	1–2
Total	**2**

(d) Describe the effect that UV light has on DNA structure. (4 marks)

Description	Marks
Describes the effect that ultraviolet light has on DNA structure (any **four** of):	
• ultraviolet/UV light is a physical mutagen or the photons in ultraviolet/UV light can damage DNA • interferes with base pairing • breaks the hydrogen bonds between bases (on complementary/ different DNA strands) • free bases pair with neighbouring bases on the same strand **or** form dimers **or** the free bases are facing each other (as shown in the diagram) • usually thymine/T or cytosine/C or pyrimidines (that form dimers)	1–4
Total	**4**
Note to markers: the diagram is a guide only, additional correct information is acceptable.	

(e) Explain why mutation is the ultimate source of genetic variation. (4 marks)

Description	Marks
Explains why mutation is the ultimate source of genetic variation:	
• mutation changes DNA sequence/structure **or** chromosome structure/number **or** permanent change in DNA • this creates new genetic/DNA variation/polymorphism **or** new alleles • only process that creates new/unique alleles • new/different alleles (which come from mutation) are needed to create novel combinations of alleles/genotypes/individuals	1–4
Total	**4**

Section Three: Extended answer **20% (40 Marks)**

Unit 3

Question 36 **(20 marks)**

(a) Describe the functions of DNA and messenger RNA. (10 marks)

Description	Marks
Describes the functions of DNA	
DNA stores/holds genetic information	1
this information is required for development/function of cells/organisms	1
information is passed to next generation/offspring/daughter cells	1
DNA contains • genes that code for (essential) proteins **or** RNA • genes that regulate gene expression **or** switches other genes on/off at correct time/in the correct cell • sequences that hold genes/DNA in the correct place in nucleus **or** that maintain chromosome structure and function • proof reading functions (to ensure replication is accurate) • DNA self-replicates **or** acts as a template to produce a new DNA strand (complementary)	1–3
Subtotal	**6**
Describes the function of messenger RNA	
RNA reads/transcribes the genetic code	1
RNA • copies the sequence of genes/DNA • take this information to the cytoplasm/ribosome • interact with tRNA/ribosome • ensures amino acids are assembled to form a protein	1–3
Subtotal	**4**
Total	**10**

(b) Explain how speciation and macro-evolutionary changes result from an accumulation of micro-evolutionary changes over time. (10 marks)

Description	Marks
Explains micro-evolutionary change (and **three** of):	
change within a population/species **or** small scale change	1
Microevolution • involves changes in the frequency of alleles/genotypes/phenotypes • via natural selection/genetic drift/mutation/gene flow • change from one generation to the next is small • operates over small time scales	1–2
Subtotal	**3**
Explains how speciation and macro-evolutionary change results from an accumulation of micro-evolutionary change (any **seven** of):	
macro-evolution is change at/above the level of species or large-scale evolution	1
occurs over many generations **or** very long periods of time	1
(over this time scale) micro-evolutionary changes accumulate into large changes	1
changes may become so great that they lead to the production of a new species **or** speciation **or** individuals that cannot interbreed	1
• macro-evolution focusses on trends/patterns within whole taxa/lineages (rather than changes within a species) **or** the evolution of new lineages (rather than species) • these patterns arise (in part) because different populations/species evolve in new/different directions by micro-evolution • life has been evolving for approximately 3.5 billion years ago (which is sufficient for very large changes to accumulate) • specific example that shows relationship between micro-evolution and macro-evolution	1–3
Subtotal	**7**
Total	**10**

Question 37 **(20 marks)**

(a) Describe how micro-evolution could result in salt tolerance in a species of plant.
(10 marks)

Description	Marks
(micro-evolution is) change within a population/species **or** small scale change	1
description includes that salt tolerance would evolve by natural selection (must state natural selection)	1
description includes that plants must vary in their ability to tolerate salt **or** that a mutation produces a genetic variant/allele that confers salt tolerance	1
Subtotal	**3**
Describes how salt tolerance could have evolved (any **seven** of):	
• plants are exposed to salt (in the environment) • plants that tolerate the salt/saline environment survive for longer/are healthier/more productive/have a selective advantage **or** the converse • (therefore the salt tolerant plants) produce more offspring compared to those that are not tolerant **or** the converse • offspring (of salt tolerant plants) inherit the alleles/genes for salt tolerance • (therefore) the frequency of the alleles/genes for salt tolerance is higher in the next generation • (so long as the salt is present) salt tolerant plants will leave more offspring compared to other plants **or** the process will continue over many generations • the frequency of the alleles/genes for tolerance will get higher and higher • eventually/after many generations all plants/the whole population will be salt tolerant **or** will have the salt tolerant alleles/genes	1–7
Subtotal	**7**
Total	**10**

(b) Explain how the use of transgenic crop plants may have adverse biological effects.
(10 marks)

Description	Marks
Effect on plant crop	
Explanation recognises that there may be a loss of genetic diversity in the plant crop	1
Explains why genetic diversity may be lost (any **one** of): • transgenic crop is a single line or strain/monoculture • only the transgenic crop may be farmed **or** unmodified crop may not be farmed (due to favourable characteristics of transgenic)	1
Explains the consequences of a loss of diversity (any **one** of): • may limit ability of crop to adapt to other aspects of the environment/pests • could reduce potential to develop desirable crop lines in the future (e.g. by selective breeding)	1
Subtotal	**3**
Effects on environment/non-target species	
Any **seven** of: Explains how transgenic overshoots environment/becomes a pest • water/pests/factors limiting growth of transgenic plant/crop removed • (therefore transgenic plant/crop) becomes a weed **or** difficult to control **or** shows increased growth/productivity • (transgenic plant/crop) may monopolise/deplete other resources/soil nutrients/water • overgrow/outcompete other plants **or** change food web Explains how the gene/trait may be transferred to other crops/species • transgenic/crop plants may exchange genes/transfer gene/genetic material to other plants/crops/species **or** introduced gene may be transferred to other plants/crops/species • resulting in (engineered) trait in another plants/crops/species • these plants/crops/species may become a weed/superweed/pest because they can no longer be controlled by pests/herbicides/low water/environmental factors Explains how the use herbicide-resistant transgenics may lead to overuse of herbicides • if the plant/crop was engineered for herbicide resistance, farmers may overuse herbicides (to kill weeds) • (overuse will) pollute the environment **or** cause evolution of resistant weeds (by natural selection as a result of exposure to a lot of herbicides)	1–7
Subtotal	**7**
Total	**10**

Question 38 **(20 marks)**

(a) Compare the methods that endotherms and ectotherms use to regulate their internal body temperature and discuss the costs and benefits of endothermy to individuals. (10 marks)

Description	Marks
Compares endotherms and ectotherms	
Endotherms generate their own body heat	1
Ectotherms rely on external environment for temperature control	1
Endotherms • (body heat is generated) from metabolism **or** biochemical/chemical reactions in cells • maintain (relatively) constant internal/body temperature • have adaptations/features/behaviour to control heat loss/gain to ensure internal body temperature remains constant	1–2
Ectotherms • (ultimately) obtain heat from sun/object warmed by sun **or** rely on external sources of heat • body temperature fluctuates with external environment • use adaptations/features/behaviour to control heat loss/gain	1–2
Subtotal	**6**
Discusses the costs of endothermy (any **two** of):	
• endotherms have a higher metabolic rate (compared to ectotherms of same size) • need to expend more energy (to fuel metabolism) or have higher energy requirements • have greater food demands or need to spend more time obtaining food	1–2
Subtotal	**2**
Discusses the benefits of endothermy (any **two** of):	
• less dependent on environmental temperatures (compared to ectotherms) or body temperature is independent of external temperature • can live in very cold environments or in a broader range of environments • active at night or at more times during a day (in places where night-time temperatures are low) • being active at night may help to reduce predation • (higher internal temperatures) may provide protection against some pathogens	1–2
Subtotal	**2**
Total	**10**

(b) Discuss the risk that zoonoses pose to human populations across the world. (10 marks)

Description	Marks
Discusses the general risks that zoonoses poses to human populations (any six of):	
(Zoonoses pose a risk because) • no/limited prior exposure • little immunity in the population • limited medical treatment/medicines/vaccines • therefore the disease could spread rapidly (once acquired from the vertebrate) • a major/important source of new/emerging diseases/pathogens **or** source of disease is unknown • environmental change/expansion of human populations/human actions could increase the risk of transmission of zoonoses • increased contact between humans and wildlife species (that could transfer disease) increases risk **or** contact made with asymptomatic animal • higher risk when there is a higher impact on host**or** vice versa • higher risk in low socio-economic countries with limited options for treatment	1–6
Subtotal	**6**
Discusses how the risk varies according to the mode of transmission (any **four** of):	
• risk varies according to mode of transmission among humans **or** between humans and other vertebrate/animal Transmission among humans • high risk from disease that can be easily transferred among people • because it could spread rapidly/widely • gives specific details of zoonotic disease being transferred among humans (or vice versa from a low risk perspective) Transmission from animal to human • high risk when disease is transmitted from vertebrate/animal in regular contact with humans **or** from domestic/food animals • high risk when disease can is easily transmitted (from vertebrate to human) **or** when the disease can be transmitted (from vertebrate to human) through droplets in the air **or** touching contaminated surfaces (e.g. as in avian influenza) • gives specific details of zoonotic disease being transferred from animal/s to human/s (or vice versa from a low risk perspective)	1–4
Subtotal	**4**
Total	**10**

Question 39 **(20 marks)**

(a) Explain why it is difficult to control the spread of tuberculosis. (10 marks)

Description	Marks
Any **ten** of:	
No more than four marks from any one heading to a maximum of ten: Explains the role of disease transmission • transmitted from human to human/by inhaling droplets (from infected individuals) **or** easily transmitted from one human to another • infected individuals may survive for a long time (so more opportunity to transmit disease) **or** be asymptomatic • increased contact between infected and uninfected individuals will spread the disease • can be transmitted from livestock Explains the role of antibiotic resistance • caused by a bacterium • was treated with antibiotics **or** treated individuals did not complete a course of antibiotics • evolved resistance to antibiotics • by natural selection/because susceptible bacteria dies/did not reproduce **or** resistant bacteria survived/did reproduce • limits ability to treat infected people Explains the role of globalisation/urbanisation • humans are very mobile/travel long distances/across regions or across the globe • this can introduce disease can into regions where does not usually occur • people may live in urban areas/areas with high population density/in unhygienic conditions Explains the role of disease management • provision of healthcare is limited/unaffordable in some places • many individuals are not immunised • hence no herd immunity **or** large numbers of susceptible people (so the disease spreads) • (infected) individuals are not treated • limited opportunity for education **or** limited facilities for quarantine of infected individuals (in some places)	1–10
Total	**10**

(b) Explain the physiological challenges that a mammal faces in maintaining its internal environment within tolerance limits in hot deserts. (10 marks)

Description	Marks
Explanation includes statement about the importance of water/access to water in hot deserts (any **one** of):	
• access to water is a challenge/problem • water is needed for multiple aspects of homeostasis **or** to maintain different aspects of the internal environment • competing demand for water among different functions	1
Subtotal	**1**
Explains the physiological challenges of temperature regulation in a hot desert (any of **four** of):	
• (mammals are) endotherms **or** need to maintain body temperature within (narrow) limits **or** avoid overheating (in hot temperatures) • (mainly) use evaporative cooling (to avoid overheating) • most evaporation occurs through breathing/respiration/panting/sweating • inhale dry air which collects water from (moist) respiratory passages • evaporation of water/changing water from liquid to gas requires energy or heat from body • results in a loss of water (so less is available for other functions)	1–4
Subtotal	**4**
Explains the physiological challenges of other types of homeostasis (any **five** of):	
Excretion • nitrogenous waste is toxic • needs to be (regularly) removed/excreted/maintained within tolerance limits • excreted as urea • (urea) can be stored for longer **or** requires less water to excrete than ammonia • (but still) need some water to excrete nitrogenous waste/urea Salt-water balance • cells/body fluids require certain balance of salts and water • important for movement/transport of water/solutes/ions (into and out of cells/across membranes) **or** for chemical/biochemical metabolic reactions • movements depend on concentration gradients **or** osmosis **or** diffusion • water is needed to maintain balance **or** lack of water will disrupt balance	1–5
Subtotal	**5**
Total	**10**

ACKNOWLEDGEMENTS

Question 31(a) Definition of biological species based on: Mayr, E. (1985). Chapter 6: Microtaxonomy, the science of species. In *The growth of biological thought diversity, evolution, and inheritance*. London, UK: Harvard University Press.

Definition of phenetic species based on: Ridley, M. (1993). Phenetic species concept. In *Evolution.* Retrieved October, 2019, from https://www.sciencedirect.com/science/article/pii/S1319562X17301365#b0105

Definition of evolutionary species based on: Wiley, E.O. (1978). The Evolutionary species concept reconsidered. In S*ystematic Biology*, Volume 27, Issue 1, [Abstract]. Retrieved October, 2019, from https://academic.oup.com/sysbio/article-abstract/27/1/17/1626671

Question 31(e) Explanation of a phylogenic tree based on: Huelsenbeck, J.P. (2019). Chapter 6: Phylogeny estimation using likelihood-based method [Abstract]. In *Handbook of statistical genomics*. Retrieved October, 2019, from https://onlinelibrary.wiley.com/doi/10.1002/9781119487845.ch6

Question 32(a) Heart rate of the Daphnia against temperature graph provided by courtesy of a member of examining panel.

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